“Carrot & the Stick”

Improving Energy Efficiency Innovation & Implementation

Through Incentives & Regulation

MPP Professional Paper

In Partial Fulfillment of the Master of Public Policy Degree Requirements
The Hubert H. Humphrey School of Public Affairs
The University of Minnesota

Jamie Fitzke

November 23, 2014

Signature below of Paper Supervisor certifies successful completion of oral presentation ***and*** *completion of final written version:*

__________________________	November 18, 2014	__________________
Elizabeth J. Wilson, Associate Professor, University of Minnesota	Date, oral presentation	Date, paper completion

__________________________________	__________________
Richard Szydlowski, `	Date

Director of Engineering & Business Development
Center for Energy & Environment
Second Committee Member
Signature of Second Committee Member, certifying successful completion of professional paper

Executive Summary

As the regulatory need for electric utilities to reduce their CO2 emissions increases, energy-efficiency (EE) programs will be a cost-effective alternative to consider in obtaining this goal. Additionally, since the enactment of Energy Independence and Security Act (EISA), Energy Efficiency Resource Standard (EERS) goals will be harder for utilities to meet. Determining whether incentives, regulations, or both in combination are most successful at innovating and implementing energy-saving technology is crucial to energy policy and demand side management (DSM). Understanding incentives that motivate installation of energy efficient equipment and creating regulations that spur innovations rather than animosity or negative externalities will lead to successful policy outcome. To achieve optimum EE, three federal lighting policies and original survey responses from DSM participants are analyzed.

Table of Contents

List of Acronyms

American Council for an Energy-Efficient Economy (ACEEE)

Carbon Dioxide (CO2)

Conservation Improvement Program (CIP)

Color Rendering Index (CRI)

Demand Side Management (DSM)

Department of Energy (DOE)

Energy Efficiency (EE)

Energy Independence and Security Act (EISA)

Energy Policy Act of XXXX (EPAct XXXX)

Energy Efficiency Resource Standard (EERS)

Environmental Protection Agency (EPA)

Greenhouse Gas Emissions (GHG)

GWh (gigawatt hour)

kWh (kilowatt hour)

Lighting Power Density (LPD)

Lighting Rebate Program (LRP)

Research and Development (R&D)

Research, Development and Deployment (RD&D)

U.S. Energy Information Administration (EIA)

1. Introduction: EE

Since the 1970s, energy efficiency (EE) has been a method to reduce energy consumption and damage to the environment. EE resurges as a popular topic with policy makers, environmental organizations, and the general public whenever energy prices increase. Power utilities, government organizations regulating utilities, and organizations concerned about the environment consider EE a resource capable of yielding energy and demand savings that can displace electricity generation from coal, natural gas, nuclear power, wind power, and other supply-side resources (ACEEE, 2014).

Now there is national motivation to evaluate the potential of EE programs. On June 2, 2014, the Environmental Protection Agency (EPA) announced details of the Clean Power Plan (also known as 111D), a proposal to regulate carbon dioxide (CO2) emissions from existing stationary sources, mainly from electric power plants (EPA, 2014). With this initiative EE will take on additional significance. In the Clean Power Plan, the EPA proposes a plan that is "flexible—reflecting that different states have a different mix of sources and opportunities" (EPA, 2014). Most energy saving technologies are available to the entire U.S. market. Therefore, EE will be viewed as a widely available source and opportunity to reduce CO2 emissions.

Nationally, EE has taken hold as a cost-effective practice to reduce energy costs and greenhouse gas emissions (GHG). Twenty-five states have adopted the Energy Efficiency Resource Standard (EERS) through regulation or legislation (ACEEE, 2014). EERS requires utilities to achieve a predetermined percentage reduction in energy sales from energy efficiency measures. Often these measures are tracked through utility EE incentive programs, also known as demand-side management (DSM), which verifies if the utility has achieved the energy savings target.

With only half of U.S. states adopting EERS, much more could be done to reduce energy consumption. Energy efficiency implementation and energy savings vary greatly between states, even those with EERS. The Rocky Mountain Institute estimates that if 40 of the lowest performing states achieved the energy efficiency per capita of the top 10 states, 1.2 million gigawatt-hours (GWh) would be saved annually. The potential savings equate to 30 percent of the nation's annual electricity use (Mim et al., 2009). This EE disparity highlights the savings still possible from EE measures.

2. Creating EE: Regulation, Incentive, or Both?

Federal regulations are critical to perpetuate EE improvements and maintain standards on a national level. Several regulations and policies enacted over the last decade impact technology efficiency minimums. These regulations set the floor, or the lowest efficiency allowed. These minimums dictate which technologies are available for consumers to purchase by making an existing technology obsolete or illegal, although there is little enforcement and many of the illegal products remain on the market (Alliance to Save Energy, 2011; Nadel, 2011; Sheppard, 2014). These regulations also negatively impact the performance and claimed energy savings from utility EE programs. Regulations that affect technology availability or remove products from the market reduce utilities' ability to offer EE incentives. Often incentives are not available when replacing obsolete technology with more efficient technology because the energy savings are no longer allowed to be claimed as savings by the utility. In other words, the "stick" of regulation takes away the "carrot" that utilities could offer customers.

When regulations determine when and why something is no longer available for purchase, consumers are often misled or don't understand why changes took place. This confusion became evident when the Energy Independence and Security Act (EISA) regulations affected consumer lighting choices. Years after EISA was approved by our federal policy makers, the EE standards set by EISA were phased into the lighting market. These changes perpetuated political grandstanding, even by those who voted for the bill, and media sensationalism of regulations banning consumer choices. Unhappy consumers now look to creative solutions or points of purchase to avoid changing a preferred light source or making forced investments into EE lighting. Additionally, economists argue regulations are wasteful, expensive, and inefficient at obtaining the EE objectives (Graetz, 2012), leaving some to question the intent and benefit of regulations.

Incentives are often offered to encourage adoption of EE technology. Incentives can take many forms (e.g., tax credits/deductions, cash rebates, financing) and are available from many sources (e.g., federal, state, local utilities). Arguments have been made that economic incentives are decidedly more effective than regulations in encouraging the cost-effective adoption and diffusion of relevant new technologies (Jaffe et al., 2004). Finding "flexible policy instruments, based on economic incentives rather than mandatory compliance methods, are more likely to encourage the development and implementation of cost-effective technology" (Jaffe et al., 2004). Use of incentives to encourage implementation of EE technology has proven to be effective (Anderson & Newell, 2004; Gillingham et al., 2006; Howard, 2007; Metcalf, 2007), but incentives also face their fair share of critics. Studies and papers have been published raising concerns of free-riding, equity, and measurement verification of EE incentive programs (Wirl, 2000; Loughran & Kulick, 2004; Graetz, 2012; Jacoby-Hawkins, 2014), all of which raise doubts to the effectiveness of incentives in obtaining energy savings. Since both the carrot and the stick have flaws, a debate ensues over which is more effective in EE policy.

While regulations and incentives are far from perfect, this paper looks to dispel the arguments that either is unnecessary in EE. Instead, I prove there is a partnership that makes the other more effective in policy and energy savings. First, this partnership is shown through an analysis of successes and failures of three prominent federal lighting policies. Second, an ex ante survey is conducted on participants in a lighting rebate incentive program. The analysis illustrates federal regulations can cause end-user confusion and resentment, but can also spur industry innovation and technological advancement. EISA is a shining example of both sides of regulation. Policies that include incentivizing innovation and technology often lead to higher EE standards, although incentivizing private business is often overlooked as a policy option. Additionally, consumer incentives spur adoption and reduce resentment of regulation. Offering the correct amount and form of incentive is needed on two fronts: private sector industry to catalyze EE innovation and the consumer to encourage EE implementation, technology acceptance, and broad dispersion.

For policy makers and DSM facilitators, understanding the impact of regulations and incentives, and capitalizing on their relationship, is crucial. A partnership between regulations and incentives could increase the potential of EE programs and technology. It is also important to recognize that a regulation, such as EISA, that bans a technology also impacts the ability to offer incentives. Incentives can be reduced or unavailable when replacing a banned technology with more efficient technology. This particularly impacts utilities in energy savings they claim and report to state EERS. The survey conducted for this paper addresses barriers to EE and how to increase participation rates in DSM programs in the post-EISA era.

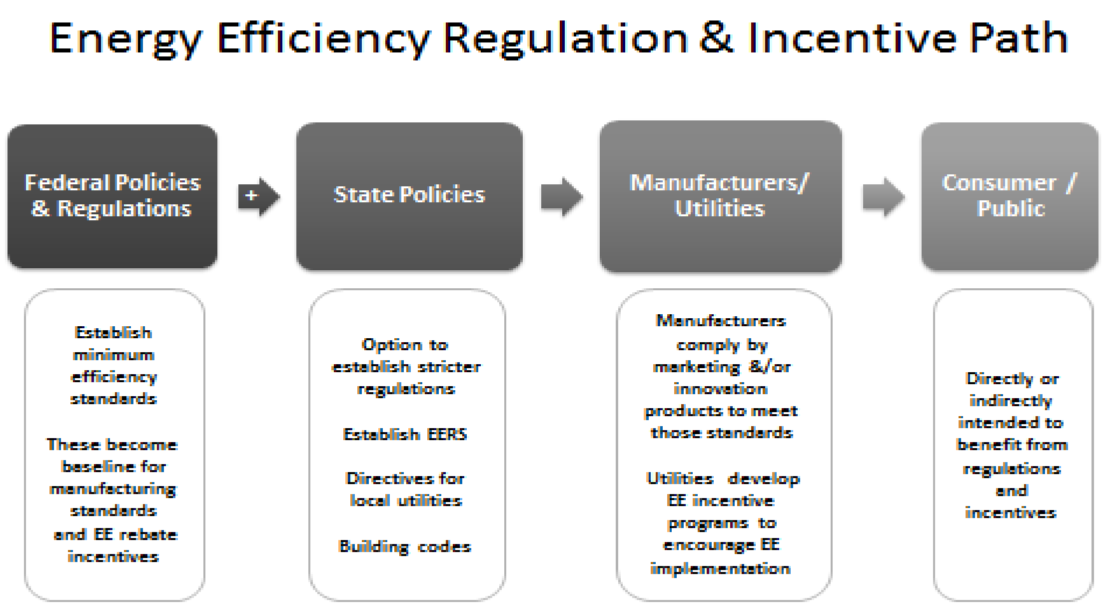


Figure 1

3. <u>Lighting Background</u>

This paper will focus on non-residential lighting uses. In 2012, commercial buildings consumed approximately 274 billion kWh of electricity in lighting alone, comprising 21 percent of the total energy used in the commercial sector (U.S. Energy Information Administration [EIA], 2014). According to the EIA, the largest electric energy consumer is non-residential buildings. In 2011, residential buildings consumed over 21 quintillion BTUs of energy (EIA, 2014). Manufacturing facilities, commercial, and industrial buildings consumed over 69 quintillion BTUs of energy (EIA, 2014). With three times the energy usage, it makes sense to prioritize the energy reduction of non-residential buildings.

Lighting technology itself has made significant improvements in efficiency. Lighting efficiency is measured in lumens per watt (LPW). LPW denotes the amount of light generated per watt of energy consumed by the lighting system. The higher the lumens per watt, the less energy you need to light up a space. Figure 2 graphs the improvements in efficiency of 4-foot linear fluorescent lamps.

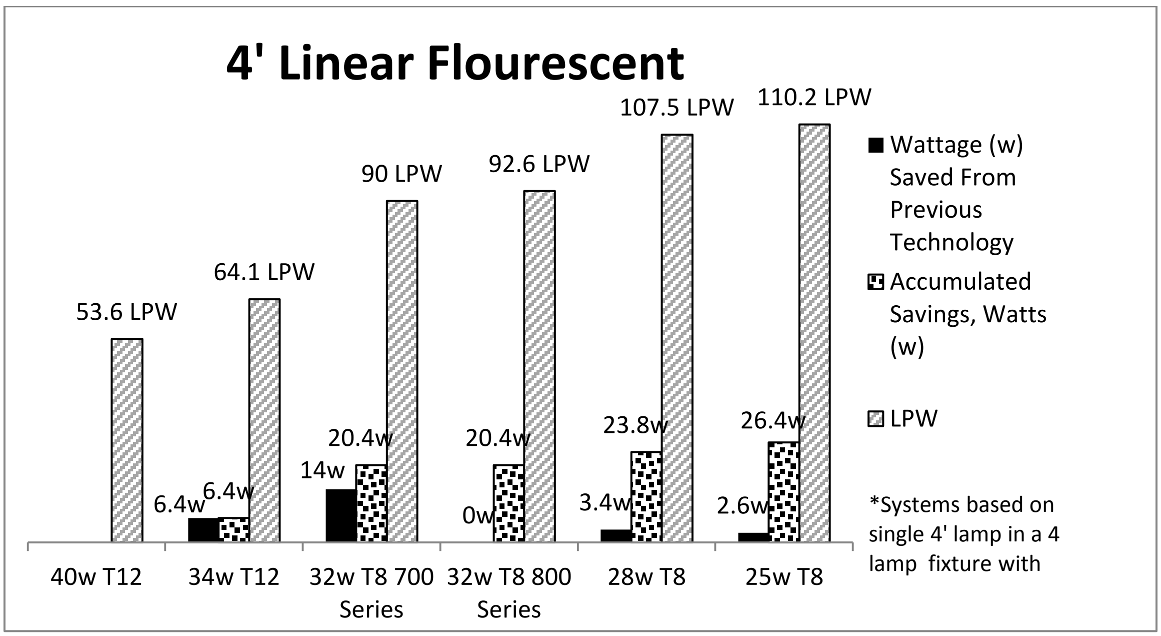


Figure 2

Lighting has also led the way as the most cost-effective EE measure, becoming a heavily utilized EE incentive program. A study by Joseph Eto reveals that majority of EE programs offered by utilities are “multi-measure programs” followed closely by “lighting only programs” (Eto et al., 2000). Multi-measure programs offer EE incentives on a mix of measures such as light, heating/cooling, refrigeration, motors, and/or building envelope. In these multi-measure programs, lighting accounted for majority of the savings compared to the other categories (Eto et al., 2000). As a total, lighting EE accounted for over 60 percent of the energy savings (Eto et al., 2000).

4. <u>Federal Lighting Regulations, Policies, & Innovation Incentives</u>

Understanding federal lighting policy impact and ability to achieve energy savings is important. Some policies have much greater impact on energy savings than others. Additionally, federal regulations, whether intended or not, have negatively impacted many electric utilities' "claimed" energy savings. Claimed energy savings is used to meet state-mandated EERS.

4.1 <u>Timeline & Rubric for Policy</u>

Beginning in the early 1990s, efficiency regulations made their first impacts on lighting. In the 25 years that have passed, federal policy has influenced lighting from research and development (R&D) to end user. The efficiency regulation from federal lighting policy has been instrumental in achieving energy savings and critical to setting efficiency minimums for lighting manufacturers to meet. Energy Policy Act of 1992 (EPAct 1992) created the first lighting efficiency regulations, becoming the blueprint for future lighting regulatory policies. Over 10 years later, EPAct 2005 created incentives for energy efficient lighting but did not regulate lighting products. The biggest regulatory game changer is EISA 2007, which significantly transformed lighting and the lighting industry.

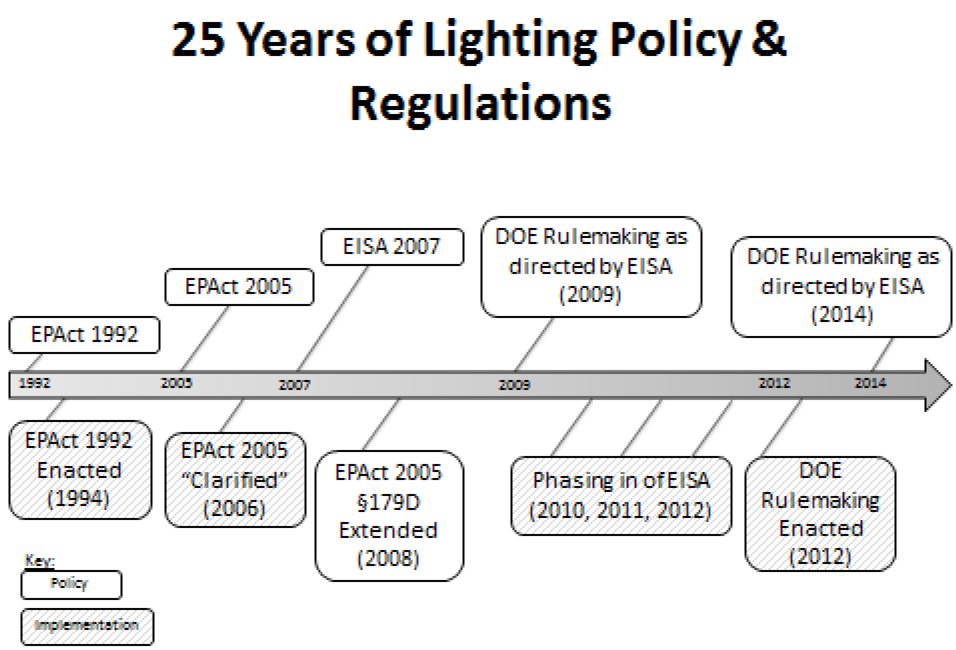


Figure 3

The following rubric is used to measure lighting policy success in achieving energy savings and transformation in the industry. Four of the points below—effectiveness, cost-effectiveness, fairness/equity, and clarity of policy—are generally important to judging a policy's success (Bardach, 2012; Smith, 2012). For purposes of this paper, ability to stimulate innovation has been included in the policy rubric.

Considerations in
EE Policy Analysis

- ✓ Effectiveness: Is the policy creating energy savings?
- ✓ Cost-Effectiveness: Is this cost-effective for the government, utility, manufacturer, and consumer?
- ✓ Fairness/Equity: Is the policy accessible and fair to the public?
- ✓ Clarity of Policy: Are the regulations and incentives clear?
- ✓ Ability to Stimulate Innovation: Will the policy lead to EE breakthroughs or improvements to existing technology?

4.2 Energy Policy Act of 1992 (EPAct 1992)

In 1992, President Bush signed the Energy Policy Act into law. This bill contains two points of interest for this paper: lighting-efficiency standards and prioritizing conservation as the preferred method of electric resource planning (Wirl, 2000). A small portion of EPAct 1992 was directed toward lighting (most would remember it for deregulating the electric utility industry), but that small portion made a very large impact in the lighting industry. EPAct 1992 set the first lighting efficiency standards, making nonqualified products illegal to manufacture or import. The lighting industry was widely impacted, and many of the most commonly used lamps failed to meet the new standards. By mid-1994, T12 4-foot and 8-foot "full-wattage lamps" (40w, 75w, 110w) were eliminated from manufacturing, replaced by more energy efficient T12 4-foot and 8-foot lamps with lower wattage (34w, 60w, 95w). By the end of 1995, incandescent reflector (commonly known as a flood light) and PAR lamps that did not meet the minimum LPW were also banned from manufacture (Osram Sylvania Lighting, 1994).

The literature from lighting manufacturers regarding EPAct 1992 states there are two ways to persuade consumers to install energy efficient lighting: elimination of product through legislation and education, paired often with utility incentives (Osram Sylvania Lighting, 1994). Additionally, there is firm belief that people will switch to more efficient lighting because it saves money. Two decades later, those siloed methods and justifications are still similar. EPAct 1992 contained many light bulb and lamp 'exemptions' to the regulations, but manufacturers did not spend time looking for loopholes. Instead they were looking ahead to 2005, the next Energy Policy Act. Acknowledging that "if anything, performance standards will be made stricter and exemptions will be eliminated...the best strategy is to pursue the intent of the legislations and make an investment in the most energy efficient technologies available" (Osram Sylvania Lighting, 1994).

EPAct 1992 was equitable; it covered the majority of lighting technology and was applied to all consumers. But considering the quality of replacement equipment, it is surprising the legislation was so successful. Much of the EE technology at the time would be considered sub-par or unsuitable replacement by today's standards. The CFLs available in the 1990s were not as warm (Kelvin color) as incandescent lamps, were low on the color rendering index (CRI), had slow start-up time, were not dimmable, and were offered in a small and often inconvenient selection of bulb shapes. EPAct 1992 did not include incentives or support lighting R&D to encourage technology advancement.

Early 1990s Lighting Technology		
	CFLs	Incandescent
Average Kelvin Color	4000K	2700K
Dimmability	No	Yes
CRI (scale of 0-100)	Mid 70s	90+
Start-Up Time	10+ seconds	Instant
Initial Investment	High	Low

Allowing lower wattage T12s to stay in circulation was a cost-effective measure. To comply, T12 users only had to replace lamps as needed, not the ballast. An intelligent move, as the more efficient T8 lighting was new to market and was earning a bad reputation for high failure rates and product issues.

4.3 **Energy Policy Act of 2005 (EPAct 2005)**

The Energy Policy Act of 2005 (EPAct 2005), designed by the Bush administration and signed into practice in August 2005, was the first major energy policy since EPAct 1992. Out of $14B available in tax incentives (projected accumulative from 2005 to 2015), 2.5 percent ($340M) was dedicated to incentivizing EE improvements in residential and commercial buildings (Metcalf, 2007). The majority of incentives went to energy producers, such as the oil industry and electric utilities, and contained few regulations (including no lighting efficiency regulations). Instead the act looked to incentivize businesses to implement energy efficient equipment in 2006 and 2007 through an accelerated tax deduction for commercial buildings.

In *"Commercial Building Tax Deduction,"* government officials looked to the IRS to define rules for the tax deduction. The IRS looked to the lighting industry, lighting professionals, and civil engineers to define energy efficient lighting. Adding to the confusion, the government officials determining the EE standard (Secretary of the Treasury) did not have the technical background to determine what the EE qualifications should be. Initially there was an interim rule until the Secretary of the Treasury, in conjunction with the Secretary of Energy, made a determination. Eventually, the rule stated that lighting power density (LPD) 25 to 40 percent lower than the minimum ASHRAE standard would qualify for the tax deduction, with warehouse spaces needing to be over 50 percent lower (DiLouie, 2005).

Eighteen months later, EPAct 2005 parameters were slightly more defined to "commercial building property that is certified to reduce total annual energy and power costs to at least 50% less than a building satisfying the [ASHRAE/IES] 90.1-2001 Standard" (U.S. Government - EPAct, 2005). This measurement involves calculating LPD by either building area or space-by-space and ensuring LPW is less than the required standard. Picking the method to qualify is selected by the lighting provider, leaving the calculation open for manipulation. Also, bi-level switching or controls of lighting were mandated for most buildings. To add to the confusion, some states had adopted standards stricter than ASHRAE 2001, leaving some projects to qualify for a tax incentive but not meet the local energy code.

Ambiguity in the policy was taken advantage of. For example, one contractor misleadingly made an argument that "bi-level" controls could mean turning one side of a large room on and leave the other half off. The intent of the policy was to allow occupants a minimum choice of off, 50 percent, or 100 percent uniform light level of the entire space. This improved design allows occupants control of light levels and potential energy savings when at the 50 percent level. Offering "control" increases the material and installation costs, which the contractor was subversively looking to avoid. This example highlights EPAct 2005's intent to properly incentivize energy efficient design, but the lack of stipulations increases opportunities for manipulation. Also of concern, the IRS did not conduct inspections to verify equipment and ambiguity remained on what constituted "certified proof" of energy savings.

The shortcomings of EPAct 2005 highlight the need for clarity, education, and equity in policies that offer incentives, as well as the importance of reviewing whether a policy has successfully achieved its intended goal (Friedrich, 2009; Geller, 2006; Gillingham et al., 2006, 2009; Nadel, 2006). This policy lacked direction and qualifying rules for 18 of the initial 24 months it was intended to exist. Those parties directed to establish guidelines and implementation of the incentives did not have the technical background to do so. Unclear policies and ambiguous qualifying standards allowed for manipulation and outright deception to obtain the tax incentives. On the other hand, those who wanted to play by the rules couldn't be certain they met the objectives. Many tax accountants were unsure if the qualifications for the accelerated deduction were met and were unsure how to apply them. There is also the concern of equity in this policy. The resources needed to take advantage of EPAct 2005's tax deductions are extensive. Most businesses would need to be of significant size to justify the dollars-per-square-foot return on the financial and time investment. In addition to the lighting equipment costs, most businesses would need to hire a certified lighting consultant or engineer, building engineer, and tax accountant in order to take advantage of the incentive. These barriers prevent or discourage many small and medium-size businesses from participating.

There is a small section in EPAct 2005 that became significant two years later in EISA 2007: Section 1008, "Prizes for Achievement in Grand Challenges of Science and Technology." In this section, the DOE was permitted to carry out contests with $5M and $10M cash prizes to recognize breakthrough achievements in R&D that were demonstrated and made available for commercial applications.

4.4 Energy Independence and Security Act 2007 (EISA 2007)

Introduced in 2007 by the U.S. House of Representatives, H.R. 6, the Energy Independence and Security Act (EISA) passed both legislative branches, and signed into law on December 19, 2007 by President George W. Bush. The goal of this legislation:

> "A bill to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the federal government, and for other purposes" (H.R. 6 – 110th Congress, 2007).

Four sections: 321, 322, 324, and 655, of the 267 Sections in EISA impact the lighting industry.

EISA's most immediate impact to the lighting industry is a labeling requirement for lamps and setting a minimum operating life and EE standard, phased in gradually over 3 years. With these regulations, 40w, 60w, 75w, and 100w incandescent lamps would be considered inefficient and no longer manufactured in or imported to the U.S. Generally EISA required incandescent lamps to be 25 percent more energy efficient, effectively removing "general use" filament lamps from the market. Though there are many exceptions for "specialty bulbs" such as high spectrum lights, grow lights, shatter proof, and three-way bulbs.

For linear fluorescent lamps (2' U bend, 4', and 8') EISA raised the minimum CRI allowed under the LPW exception. Previously established in EPAct 1992, the CRI increased from 82 CRI to 87 CRI. While EISA did not spell out a LPW efficiency

Pre-EISA Wattage	Maximum Wattage Allowed Under EISA	Effective Date
100 watt	≤ 72 watts	January 1, 2012
75 watt	≤ 53 watts	January 1, 2013
60 watt	≤ 43 watts	January 1, 2014
40 watt	≤ 29 watts	January 1, 2014

increase, it did direct the DOE to review and revised all linear fluorescent lamps (T12, T8, and T5). With the change of LPW and CRI requirements established in EISA, all 'non-specially' T12 fluorescent lamps and many low CRI T8 fluorescent lamps would not meet the efficiency standards. The DOE was also direct to review and revise reflector and PAR lamps. EISA's creators provide stipulations for future revisions to the LPW standard. This was two-fold, to ensure goals are reachable and to increase EE standards as technology improves and becomes market ready.

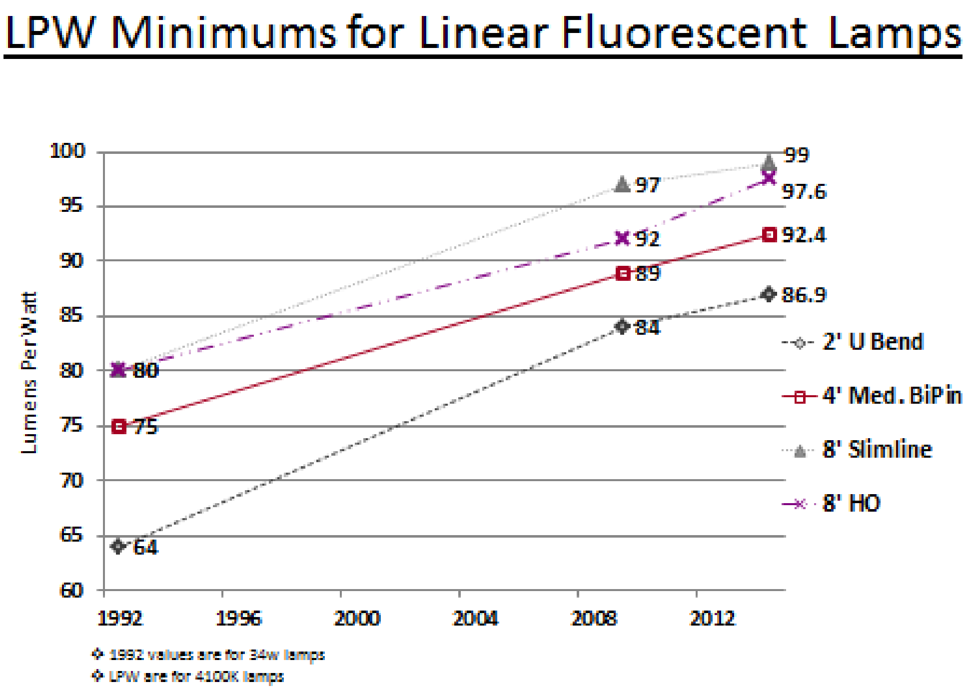
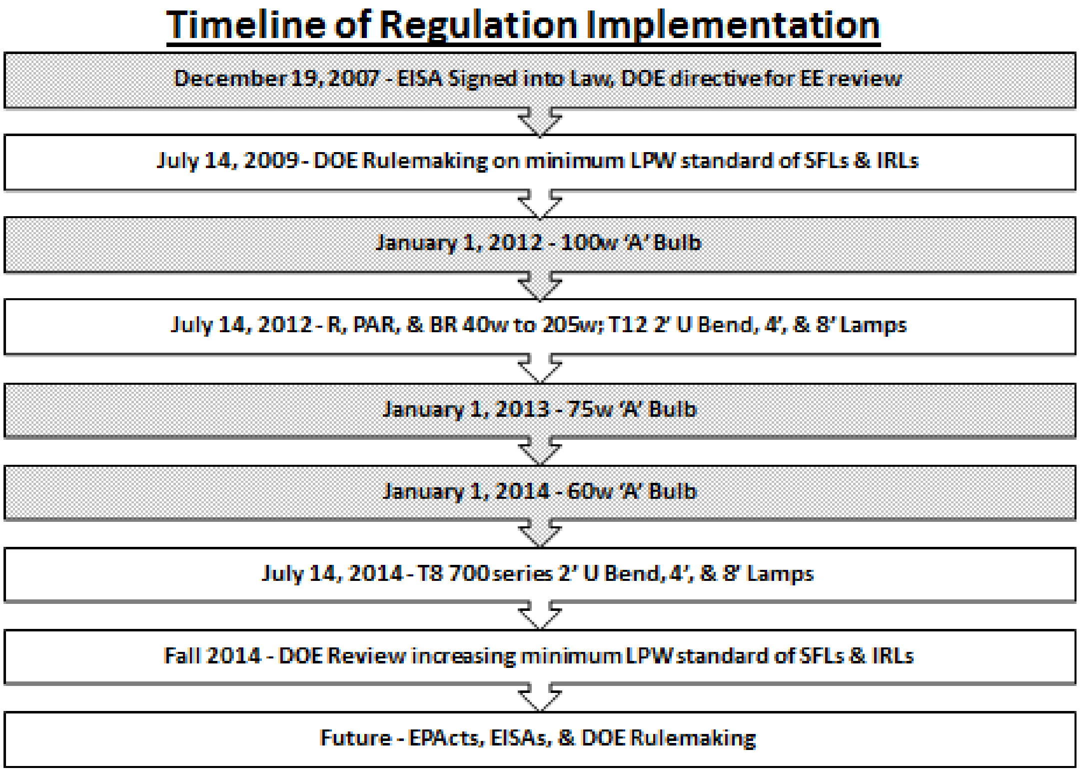


Figure 4

In 2009, eighteen months after EISA directed the DOE to revise minimum lamp efficiency standards, the DOE announced its rulemaking. Effective July 14, 2012, the LPW revision would essentially make all 'general use' T12 linear fluorescent lamps obsolete. Additionally, many reflector lamps would be no longer meet efficiency minimums. Further into the future (July 14, 2014), the DOE mandated certain T8 bulbs, which were considered efficient at the time, would no longer meet the LPW requirement. As of Fall 2014, the DOE is considering increasing the minimum LPW standard for linear fluorescent and reflector lamps. This review and rulemaking potential is at the very earliest of the 3-year period (2014 through 2017) specified by EISA.



EISA standards (shaded fill), DOE Rulemaking (no fill) Figure 5

Between EISA and DOE's 2009 rulemaking, majority of light sources used by the public would be affected by new LPW regulations. Meaning consumers would either need to purchase new lighting fragmentarily (as their existing inefficient systems stopped working) or consider making a significant investment (replacing all of their existing lighting with more energy efficient product). Either way, the regulations would accomplish removing inefficient lighting from the market.

Both EISA and DOE's 2009 rulemaking relied heavily on technological advancements in lighting. Solid state lighting, or the better known acronym LEDs (light emitting diodes), were created in the 1960s and mainly used in electronic components, not as a light source. In 2007, consumer available LEDs averaged 30 LPW and mainly available in colors, not while light (US DOE, 2013). Another issue was cost-effectiveness. There was the potential to create 'white light' by combining red, green, and blue (RGB) LEDs, but the cost and packaging size would make consumer applications impossible. R&D of LED chips were making strides. In 2005 a white LED chip with 70 LPW was created and in 2009 100 LPW white LED chip (CREE, 2010). Though it is important to note this is a laboratory setting and the chip wasn't "in" a bulb or fixture. This diode is just one piece of a complicated LED lamp. Without significant technological advancement and/or innovation in lighting products, particularly LEDs, efficiency goals would be nearly impossible to meet.

To help advance LED innovation and incentivize the lighting industry, a 'carrot' was offered among the 'sticks' in EISA. Section 655 mandated the '*Bright Tomorrow Lighting Prize*', known in the lighting industry as: The L Prize.

This section establishes cash prizes* and federal government purchase contracts of the winning products:

- $10 million is authorized for a 60-watt incandescent replacement LED product
- $5 million for a PAR38 halogen replacement LED product
- $5 million for a 21st Century Lamp

*(These amounts were determined under EPAct 2005, Section 1008 'Prizes for Achievement in Grand Challenges of Science and Technology'.)

Definitions for product entry specifications include: shape of lamp, efficiency, CRI, minimum life of lamp, and light distribution from the lamp. Also, mass production of product must be possible. The DOE is charged with designing the technical review of the product. Details on the L Prize follow this section.

Out of all lighting policies, EISA has made the greatest impact. Incandescent lamps were essentially removed from the market. The DOE was charged to review, revise, and mandate EE standards in all general use lighting. In addition to designing and facilitating successful innovations contests. The market dispersion of LEDs and feasibility of meeting EISA's EE regulations would be contingent on a successful *Bright Tomorrow Lighting Prizes* campaign. Manufacturers had to confront two issues: discontinuing the manufacturing of the deemed "inefficient" bulbs and innovating product to meet the new efficiency standards.

Often overlooked in this process, utilities had significant changes to rebate incentives and energy savings goals to consider. First, they would have to analyze new lighting products, deciding if and how much rebate incentive to offer for these products. Second, with EISA and DOE rulemaking removing T12s, certain flood lights, and incandescent lamps from the market, utilities would have a difficult time offering rebate incentive to customers who have these products. Rebates are intended to incentivizes installation of more efficient products, not reduce the cost a replacement system that meets the new minimum standard. This also decreases utility's 'reported savings' for EE programs. For example, EISA perpetuated the adoption of new EE baselines for Xcel Energy and alternative CIP lighting rebate programs (Xcel Energy, 2103). In complying with these changes actual energy savings could be higher than reported savings, for instance a 100w incandescent would be rated as a 72w existing wattage, highest allowable wattage replacement lamp in the market (See EISA Incandescent Chart for reference).

For example, a 17w LED replaces a 100w incandescent, the reported savings to State EE programs would be 55w, not 83w. This significantly changes the amount of *reported* energy saved, which should be considered in future year-to-year comparisons. Particularly any programs after 2012, the last year production of T12 and 60w incandescent lamps are allowed.

	Actual Savings	Reported Savings
Existing lamp	100w inc	
Market allowance		72w inc
Replacement Lamp (-)	17w LED	17w LED
Wattage saved	83w	55w

Some politicians have expressed interest in undoing EISA standards enacted on freedom of choice or claiming the policy hurts lighting manufacturers (Nadel, 2011; Sheppard, 2014). The National Electrical Manufacturers Association (NEMA) and leading lighting manufacturers have unanimously supported keeping the standards EISA enacted. First, reversing EISA would allow the "banned" light bulbs these manufacturers have stopped producing back into market, which would mainly benefit overseas manufacturers. Second, many states already have efficiency laws. EISA reduces the patchwork of state laws and efficiency standards by setting a minimum, which helps lighting manufacturers streamlining product assortment. While EISA had some unintended consequences, such as the reduction in “claimed” energy savings for electric utilities, majority of EISA’s lighting policy have made positive impact to the lighting industry and EE.

4.5 Policy Comparison

Using the rubric in the start of this section, the policies are compared to one another.

Policy Highlights	Check List of Successful EE Policy	Success from	Failures
<u>EPAct 1992</u> Prioritizing conservation as the preferred method of electric resource planning First lighting efficiency regulation Set lumen per watt minimum for PAR lamps, 4’ and 8’ fluorescent lamps Affected the most popularly used lamps Largely effective in energy savings, due to widespread impact Blueprint for future regulatory policy	EE Effectiveness √ Cost-Effective √ Fairness / Equity √ Clarity √ Stimulate Innovation	Giving energy conservation value Largely effective in energy savings, due to widespread impact Cost-effective for government to regulate, minor cost increase to manufacturers and consumers Applied fairly throughout lighting industry and to consumers Clear regulations set for manufacturers, became blueprint for future regulatory policy	Didn’t support or encourage innovation in lighting technology Relied on manufacturers to self-improve existing technology or for consumer demand to warranty lighting technology improvements.
<u>EPAct 2005</u> No changes in efficiency regulation Accelerated tax deduction incentive Ambiguously defined and loose oversight Largely ineffective in promoting energy savings ‘Prizes for Achievement in Grand Challenges of Science and Technology’	EE Effectiveness Cost-Effective Fairness / Equity Clarity Stimulate Innovation √	‘Prizes for Achievement in Grand Challenges of Science and Technology’ provides the DOE with the resources and guidance to establish awards for technology innovation Helps to remove uncertainty in technology, rewards R&D, and lessens the negative externality of investing in RD&D.	Slightly improved EE of projects that were already or most likely moving forward Expensive to meet qualifications, benefit of energy savings to cost of implementation is low Lacked equity, obtaining the incentive required significant time and financial investments Ambiguous requirements, confusing for the duration of tax incentive
<u>EISA 2007</u> Labeling requirement for lamps Minimum EE standard, essentially banning incandescent lamps & raises the minimum CRI LPW exception DOE directive to review and revised minimum LPW standard for PAR and reflector lamps, U bend, 4’, and 8’ fluorescent lamps Directs DOE to create ‘*Bright Tomorrow Lighting Prize*’: L Prize Mandates review and potential increase of LPW standards between 2014-2017	EE Effectiveness √ Cost-Effective ? Fairness / Equity √ Clarity √ Stimulate Innovation √	Significant energy savings due to inefficient product removed from market and increased LPW standard for majority of available lighting products Applied fairly throughout lighting industry and to consumers Clear regulations set for manufacturers Directs DOE to create ‘*Bright Tomorrow Lighting Prize*’: L Prize. Highly successful in advancing LED lighting technology.	Increased LPW standard removed many lighting products from the market, making lighting updates expensive, particularly after lighting incentives to consumers were reduced or discontinued Reduced and discontinued incentive impact utilities ability to claim ‘actual’ energy savings

In addition to the rubric, energy savings potential and increased efficiency as sole components of policy success is represented below. The graph reflects the energy savings potential of 4’ linear fluorescent lamps as new and improved technology is mandated. T8 4’ 28w and 25w lamps have been available since the late 2000s.

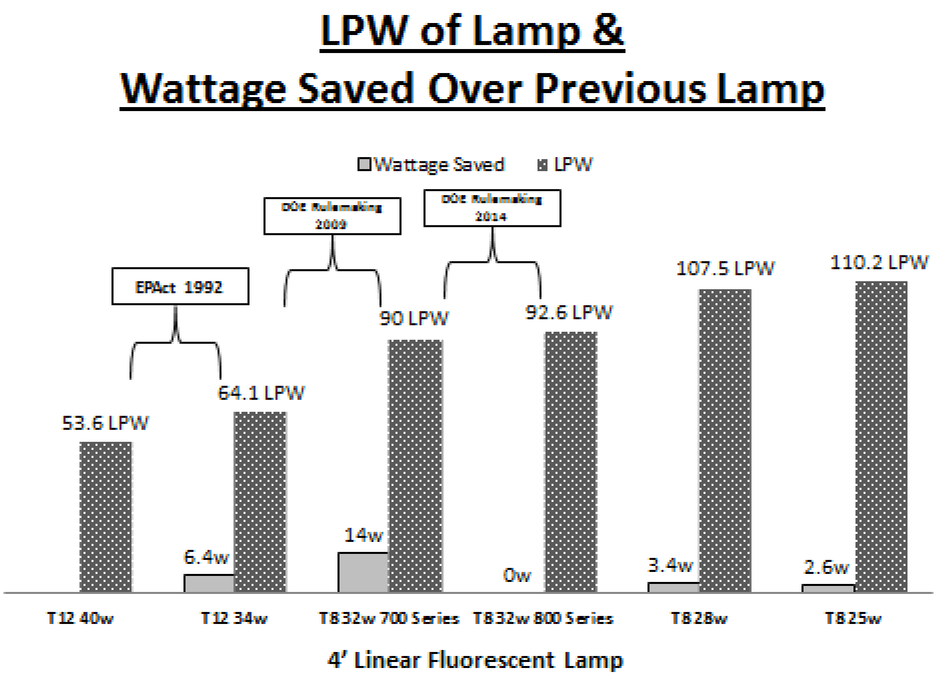


Figure 6

In summary, the most effective Federal lighting efficiency policy is EISA 2007. EPAct 1992 successfully regulated inefficient equipment from the market in a cost-effective and equitable manner, but didn’t encourage innovation or technology advancement. EPAct 2005 was the opposite. It wasn’t cost-effective, equitable, or significantly impacted energy savings, but did create an outlet to foster innovation through ‘Prizes for Achievement in Grand Challenges of Science and Technology’. The cost to implement new lighting due to regulations can be argued against EISA 2007’s cost-effectiveness. But EISA 2007 is highly successful by regulating and removing inefficient equipment, mandating the DOE periodically review lighting efficiency standards, and creating a competitive incentive contest to spur lighting innovation. By combining regulations and incentives, energy savings is maximized. This is explored further in the L Prize.

5. <u>Combing Regulations & Incentives: The L Prize</u>

EISA is the first Federal lighting policy to include an innovation contest and award incentive. The L Prize contest revolutionizes the lighting industry and changes the lighting market by focusing R&D on the LED.

5.1 L Prize Background

Sponsored by the DOE as directed by EISA 2007, the L Prize is the first government-sponsored lighting technology competition. The L Prize purpose is to stimulate lighting manufacturer competition to foster innovation in LED lighting and accelerate market availability of LED lighting.

The L Prize submission process as specified by the DOE:

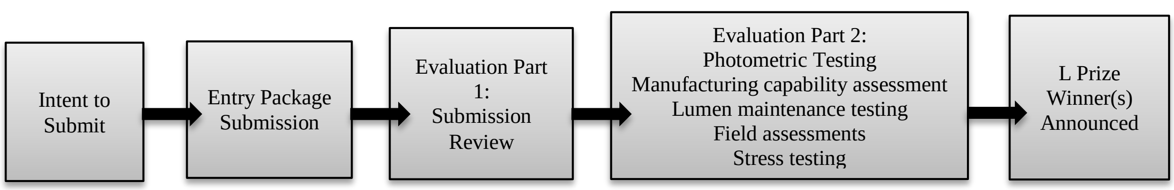


Figure 7

There L Prize consists of three award categories: 60w 'A' bulb incandescent LED equivalent replacement, PAR 38 halogen replacement, and a not yet fully developed category for an LED lamp that delivers over 150 lumens per watt, known as the '21^{st} Century' lamp.

The 60w replacement L Prize winners would be awarded a cash prize of $10M, federal purchasing agreements, utility and other incentives. In August 2011, Philips Lighting was awarded the L Prize in the 60w incandescent replacement category. No other lighting manufacturer submitted to the category after Philips Lighting. Whether it is sour grapes, lack of technical capability at the moment, or a conscious financial choice is unknown.

Currently the PAR 38 replacement has been suspended due to inability to reach the minimum LPW required. Effective June 13, 2014 the DOE announced no entries would be accepted, "current LED PAR 38 products on the market fall far short of reaching the rigorous L Prize targets, making it unlikely DOE will receive a qualifying entry in a reasonable amount of time" (U.S. DOE, 2014). The DOE makes clear that Congress set the qualifications and DOE is not allowed to lower the efficacy (LPW) target required, but will monitor the market in hopes to re-open the contest. The lofty '21st Century' lamp contest guidelines are under development and hope to be open for competition in the future.

5.2 L Prize Theory: Incentivizing Innovation

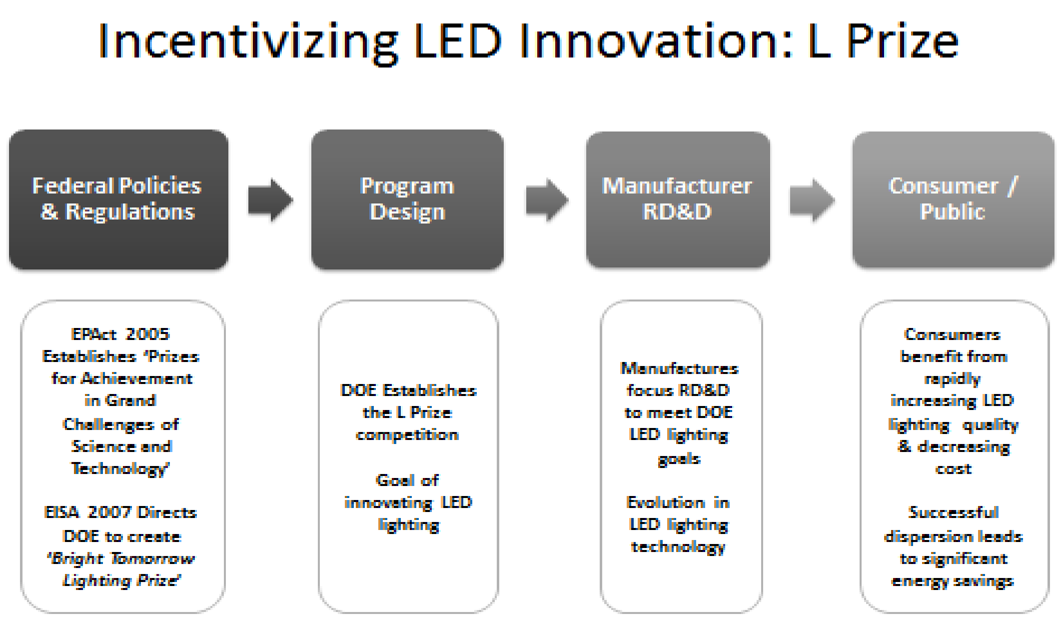


Figure 8

If a technology is "particularly desirable", narrower RD&D policies should be pursued, including technology prizes and financial incentives (Fischer et al., 2012). Policies that generate technology may be as, or more important for helping the environment, then the rules and regulations we typically think of as environmental policies (Jaffe et al., 2004). Providing targeted assistance to innovation can reduce market barriers, negative externalities, and accelerate market penetration (Tonn & Peretz, 2007; Fischer et al., 2012). The L Prize is an excellent example of technology benefitting the environment and reducing market barriers and negative externalities to innovation. The L Prize highlights three important issues:

- Program/contest design is critical for success
- Importance of reducing negative externalities in innovation
- Incentives work

5.2.1 Program Design

Getting the design of the contest and prize correct is critical (Newell & Wilson, 2005). It is important for policy makers to minimize asymmetrical information by either understanding the technology to be incentivized or seek advisement by specialists in the field. This is accomplished by directing the DOE to design and manage the L Prize.

LED lighting had potential, but focused RD&D was needed to expedite marketable product. Narrow definition, specific, and measurable objective allow competitors to know where they should focus their efforts in a technology contest (Newell & Wilson, 2005). By clearly stating in EISA the L Prize parameters and DOE setting clear technical and submission requirements, lighting manufacturers have a greater probability for success.

To counteract the uncertainty of investing in R&D, the L Prize offers large incentives to the winner(s). An ex ante prize, when the “technological threshold or target is specified prior to when the research takes place” (Newell & Wilson 2005), focuses lighting manufacturers R&D and gives them incentive to be the innovator. Manufacturers’ motivation could be based on financial award, government purchasing policy, publicity, or prestige. Development of L-Prize qualifications and reward was successful in providing enough incentives to encourage manufacturers, but not overly large which could lead to R&D saturation. It also set the precedence of open technical competition in lighting.

The L Prize galvanized the lighting industry by fostering a highly competitive and technical competition with limited winners. Manufacturers realized if they didn't win, some else would. In order to stay relevant and prosperous in the lighting industry they would need competing product.

5.2.2 Reducing Negative Externalities

Technology is not free. R&D takes place in private and public institutions to create innovation, which is expensive and without guarantee of financial return. Traditionally, patents and property rights are how innovators are temporarily reward for their invention. But patents and property rights are time sensitive or often infringed upon with limited courses of action. Knowledge spillover takes place when an innovative product is brought to market, competitors can learn and copy the process or technique, the financial recuperation of the innovating firm becomes a fraction of the original financial gain (Jaffe et al., 2004). Similarly, learning effect can inhibit innovation, as competitors benefit from the experience of their predecessors, who have often shouldered most of the RD&D costs (Fischer et al., 2012).

Additionally, economies of scale are an issue for many new technologies (Tonn & Peretz, 2007). Production costs are high and there is initial uncertainty on market penetration. Furthermore, even if the innovative product becomes commercially viable, there is no guarantee of market adoption or diffusion. This can inhibit implementation of energy savings technology, as no one wants invest in an unproven product.

The L Prize resulted in the innovation paradox of knowledge spillover to competitors, as many of the winning design components and thermal properties are copied by competitors. As seen in Figure 9, the LPW in LEDs significantly increases. This is due to knowledge spillover and decreased learning effect, which has led to continual improvements on LED design. Though through the L Prize, the DOE is successful at counterbalancing knowledge spillover for the winning manufacturer. This is done by expediting diffusion of the winning product through correcting imperfect information held by consumers. Uncertainty about quality and reliability of a new technology can lead to short-sided choices and behavioral failure, which inhibit dispersion of new technology (Tonn & Peretz, 2007; Fischer et al., 2012). Due to DOE's rigorous testing and government installations, the government is able to influencing market adoption by signaling to the public that LED technology is market ready. Additionally, EISA's LPW minimum policy encourages market growth, while DOE garners consumer acceptance of the new technology. This is particularly true for the L Prize winner: Philips LED. Through the DOE's endorsement, installations, and recommendation Philips product is viewed as superior in comparison to competitors.

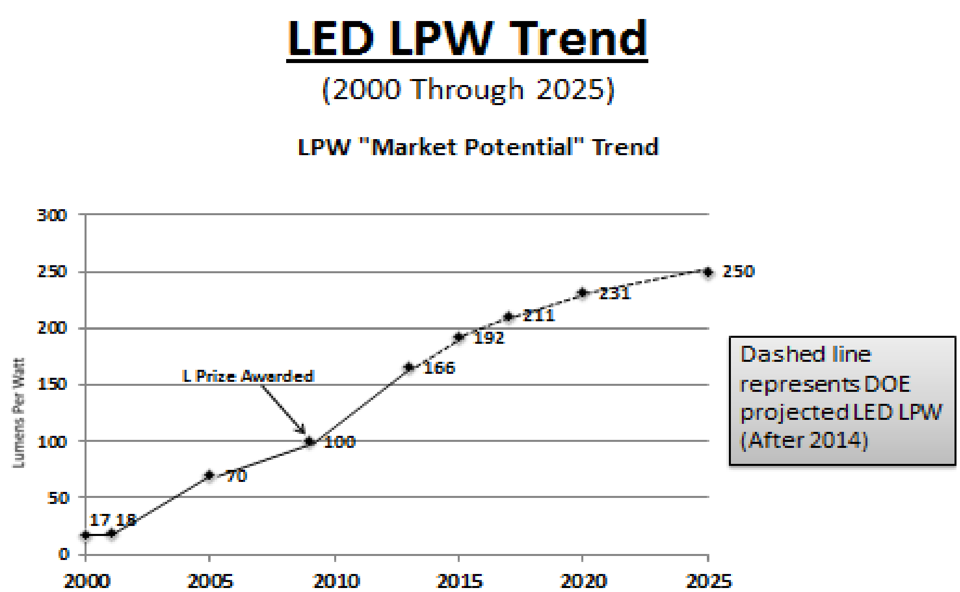


Figure 9

Government use of award or cash incentives can spur innovation and technology growth. The private R&D invested into this competition made LED lighting not only possible, but substantially improved the technology. This is shown by the dramatic increase of LED LPW once the L Prize was awarded (Figure 9). Data from: DOE: Solid-State Lighting Research & Development – Multi-Year Program Plan, Quinn: LED History 101.

5.2.3 Incentives work

Innovation contests can lead to successful technological breakthroughs (Newell & Wilson 2005). By incentivizing companies to actively compete, reaching the technical innovation goal improves. So does the potential of one and eventually more of these companies developing competing products, which eventually reduces cost and increases dispersion. Looking to encouraging innovation and increase dispersion, offering a contest or reward helps complete both these goals.

Finding the right incentive(s) is key. Publicity from the DOE and product priority in government contracts is worth more than any cash award the DOE could offer. In an interview Philips Lighting CEO Zia Eftekhar is asked about the $10M prize associated with winning the L Prize. Eftekhar responds, “Philips’ investment in the development of the L Prize far exceeded the award money” (Illuminating Engineering Society, 2011). Cash incentive and purchasing agreement (another form of cash incentive) are important to defray R&D costs, but publicity is more important. Publicity or “bragging rights” may be hard to associate a dollar value, but can be a large or *the* motivating factor. By creating correct incentives, the L Prize not only led to significant energy savings, but transformed the lighting industry.

The L Prize catalyzed significant improvements in LED lighting. This allows for EE savings many years earlier than expected. Additionally, it is a success story of regulations and incentives complementing each other to achieve significant energy savings potential. Policy makers should review and apply this relationship to other technology and EE programs.

6. State EE Regulation & Incentive: Minnesota

Taking EE a step further than Federal regulation, many states have enacted their own EE requirements, known as EERS. State requirements take into account Federal efficiency minimums, as the Federal policies often establish the minimum baseline for rebate programs. EERS typically set EE goals for utilities to meet and offer incentives to meet these goals.

Minnesota has been aggressive in setting high EERS for utilities to meet. One of the most significant initiatives toward increasing EE is Minnesota's legislature and governor passing the Next Generation Energy Act of 2007 (NGEA). NGEA is another example of regulation paired with incentive. The NGEA legislation set statewide goals for reducing energy consumption and CO2 emissions (Revisor of Statues – State of Minnesota, 2007). This is accomplished through increasing investments and setting mandatory goals for renewable power and energy conservation programs (MnSCN, 2014). Typically cash incentives from the utility are offered to EE program participants, with the utility recouping those costs from the state. Minnesota utilities use Conservation Improvement Programs (CIP) to track energy savings and apply for compensation in meeting the energy regulations. A 2012 analysis of state incentives, policies, and combinations find utilities with DSM programs located in states with EERS policies "achieve a significantly great amount of electricity savings" than those without such combinations of policy and incentives (Carley, 2012).

In 2013, Minnesota ranked 11^{th} on American Council for an Energy-Efficient Economy (ACEEE) annual "*State Energy Efficiency Scorecard"* (ACEEE, 2013). This *State Scorecard* compares each state's EE policy and programmatic efforts. Taking into account not only current EE policy, but the continued and long-term efforts to expand and grow EE programs. These policies reflect investments in EE and renewable energy programs, in addition to mandatory building energy codes. While 11^{th} place is a solid ranking, Minnesota has fallen from previous rankings of 8^{th} in 2011 and 9^{th} in 2012 (ACEEE 2011, ACEEE 2012). Minnesota has made significant advancements in EE policy and regulations, though more can be done. Especially if Minnesota wants to be a leader in energy savings and reducing CO2 emissions.

Of particular concern to power utilities, State, and Federal officials is the cost-effectiveness of EE and CO2 reductions. Utility EE programs have long been touted as the most cost-effective solution to reduce CO2 emissions and manage energy needs (Eto et al., 1996; Tonn & Peretz, 2007; Friedrich et al., 2009). A 2007 study finds EE program benefit-cost ratios are typically greater than 3:1 (Tonn & Peretz, 2007). According to a 2009 study by ACEEE, the cost of implementing EE incentives by utilities range from $0.016 to $0.033 per kWh and an average cost of $0.025 per kWh (Friedrich et al., 2009). Other research on the cost-effectiveness of utility EE programs found the cost to be $0.037 kWh to implement (Eto et al., 1996). This is compared to the cost of generating power from low CO2 sources, such as combined-cycle natural gas ranging from $0.07 to $0.10 kWh and no CO2 emission energy source of wind costs between $0.04 and $0.09 per kWh (Friedrich et al., 2009).

Minnesota's largest electric utility is Xcel Energy, providing service to 60% of Minnesota's electric customers (Burdette, 2014). In their 2013 Minnesota CIP regulatory filing, Xcel Energy reports spending of $79.6M on their electric EE portfolio with approximate net benefits of $250M (Xcel Energy, 2013). The benefit-cost ratio of over 4:1 is excellent.

6.1 Utility EE Program: Lighting

Lighting EE incentive programs offer significant and cost-effective energy savings. Xcel Energy attributes success in their Business Segment primarily to Lighting Efficiency and Process Efficiency programs (Xcel Energy, 2013). Lighting Efficiency and alternative CIP lighting programs saved approximately 100.1 GWh and comprises 30.7 percent of all energy savings in 2013 (total energy saving from Xcel Energy's business 2013 EE portfolio, including alternative CIPs is 325.6 GWh) (Xcel Energy, 2013). Lighting program benefit to cost ratios is well over 1.0, which is considered the minimum threshold of a cost-effective program. Xcel Energy submitted a Total Resource Cost Test benefit-cost ratio of 1.88 and Societal Test benefit-cost ratio of 1.93 for its lighting EE incentive programs (Xcel Energy, 2013).

Xcel Energy provided over $10.5M in rebates to 2013 lighting efficiency participants (Xcel Energy, 2013). This comprises 38 percent of the total rebate dollars offered in the EE portfolio (total business segment and alternative CIPs rebate incentive paid in 2013 is approximately $26.7) (Xcel Energy, 2013). In 2013, out of 21 business segment and alternative EE programs offered by Xcel Energy, lighting incentive programs are second only to computer efficiency in highest participation utilization (Xcel Energy, 2013).

Utilities and DSM programs in the "post-EISA era" face new challenges in reaching EE goals. The 2013 CIP filing reflects the first year after EISA standards have eliminated the most egregiously inefficient lighting. Also due to EISA, this filing reflects the first energy savings calculations using lower existing baselines wattages, which affects reported energy savings. While 100.1 GWh savings in 2013 is significant, Xcel Energy's 2012 CIP filing reported 152.7 GWh savings from Lighting Efficiency and alternative CIP lighting programs. Reflecting a 34 percent drop in reportable savings, while State EERS goals remain the same. In addition to State requirements, utilities may use DSM to meet EPA CO2 emission regulation. While EISA is successful in raising lighting efficiency standards for the nation, it also creates new barriers for utilities in reaching state mandated EERS through DSM programs. Many of the barriers will stem from consumer awareness and ability to increase DSM participation rates to offset lower claimed savings.

Questions to address these barriers include:

- Are utility customers aware of regulations affecting them?
- Will utility customers become resistant to implementing EE improvements due to 'force' of regulations?
- How will utilities meet EE goals with decreased reported savings due to EISA's impact?
- What can be done to encourage utility customers to adopt the newest energy efficient lighting technologies available, such as LEDs and 25w and 28w 4' T8 lamps?

Program evaluators, policy makers, utilities, and private sector professionals need methodologies to evaluate and estimate how DSM rebate incentives affect implementation of EE equipment (Horowitz, 2001, Newell & Wilson, 2005). Studies of rebate program participants can provide needed information on the public's comprehension of regulations, in addition to *if* and *what* incentives catalyze EE implementation. Thorough evaluations of EE rebate programs will increased policy makers understanding of the actual effectiveness and efficiency of policy, in addition to how policy design influences the results they achieve (Newell & Wilson, 2005). Majority of empirical evidence on effectiveness of financial incentives are based on tax credits and tax incentives (Metcalf, 2007; Gillingham et al., 2009). The survey and evaluation conducted in this paper is different from previous studies, as respondents are DSM rebate program participants. This analysis seeks to understand participant motives, impressions, and barriers to EE in the "post-EISA era". Allowing the analysis and results to serve as a tool to overcome such barriers and improve future EE policy.

7. Survey Background & Methodology

The Lighting Rebate Program (LRP) provides technical assistance, facilitates rebate, and offers financing assistance to participants. These participants are non-residential electric utility customers, who are considered to be a small to medium energy user as defined by the electric utility.

In March of 2014, a semi-annual survey was sent to participants in the LRP. Participant would be defined as a single employee or representative of a business that received a rebate incentive through the LRP (referred to as respondent or participant). These survey results represent respondents who participated in the LRP from June of 2013 through December of 2013. The timing is significant, because these are the first participants in the LRP after EISA and DOE lighting regulations came into full effect. The change not only includes available lighting technology, as most incandescent and T12 lamps are discontinued, but also modifications in rebate structure for these existing systems.

This is the first time questions were included to solicit participant's opinions, impressions, and knowledge of lighting regulations, rebate incentives, and incentive preference between a cash rebate or 0% interest rate financing. The survey consisted of 20 questions, 8 of which applied to this study. These questions are grouped by topic, collecting mainly nominal data, and survey structure involving: multiple choice (multiple response and single response), comparative, Likert scale, and conditional branching. No survey completion incentives are offered to participants.

There were a total of 690 projects that received rebate during this time span, with approximately 448 unique users. A unique user may have had one or multiple projects that participated in the LRP. A single project within the LRP would consist of a building site with one or multiple electrical meters, under one account holder, with an individual address. A unique user with multiple projects would be for example, a property manager of a multiple building apartment complex or an owner of multiple chain restaurants. Given the redundancy of responses, they represent only one respondent within the survey. This was done to reduce "weighting" of survey respondents.

Three methods were employed to solicit survey responses: email, mail, and follow up phone call with offer to complete survey via phone call. First, the online survey link was emailed to all available contacts through a survey system with two subsequent reminder emails to participate in the survey. The online survey participation window ran for 6 weeks from end of March 2014 to mid-May 2014. Out of 310 unique email contacts, 104 respondents answered one or more questions, resulting in a 33.5 percent response rate. Once the online survey was closed, 138 surveys were mailed to unique LRP participants. One month after mailing surveys, a calling service placed phone calls to 105 unique LRP participants who had not completed an online or mailed survey, with an offer to complete the survey via the phone call. Tracking methods are employed to prevent duplicate response. Of the 138 mailed surveys and the 105 phone surveys, 202 respondents answered one or more questions. Overall, out of 448 potential unique respondents, 306 responded to one or more of the questions, resulting in a response rate of approximate 68 percent.

7.1 **General Survey Limitations**

While obtaining raw data and compiling three survey methods (online, mail, and phone) the possibility of recording error is present. Every effort was made to ensure best survey practices took place, providing unbiased responses (Alreck & Settle, 2004). It is necessary to acknowledge a variety of errors may have unknowingly taken place and/or out of survey administrators control.

7.2 **Sampling Biases**

- Non-response bias (Alreck & Settle, 2004): LRP participants who have a positive experience maybe more likely to complete the survey than those indifferent about the program. Higher participation response could also come from participants who had a poor experience, which would counterbalance potential to skew the data.
- Self-selection bias (Alreck & Settle, 2004): Response to the survey is voluntary.
- Accessibility bias (Alreck & Settle, 2004): Some respondents are easier to access and could become over selected. With 3 types of survey media options (online, mail, and phone) and follow up, this bias is significantly minimized.

7.3 **Response Biases**

- Social desirability bias (Alreck & Settle, 2004): Respondents may overstate their desire for participating in LRP due to environmental concerns, instead of financial savings, as environmental concern appears more socially desirable or acceptable. Additionally, in desire to appear knowledgeable, respondents may overstate their awareness or knowledge on lighting and/or regulation.
- Acquiescence Bias (Alreck & Settle, 2004): Majority of respondents replies by the less personal format of online or mail survey. This reduces desire to be "agreeable" to the survey facilitator.

- Order (or Sequence) Bias (Alreck & Settle, 2004): LRP respondents may become complacent in responses, settle into routine responses, and/or suffer from survey fatigue.

7.4 <u>Survey Composition</u>

To respect the time of respondents, there is a concerted effort to make the survey brief and focused. With this in mind, there are limitations in question clarity and vocabulary. This could cause some respondents to not fully understand terms or inaccurately respond, causing instrumentation bias and error (Alreck & Settle, 2004). Though all efforts are made to fully explain in plain, non-technical terms survey questions and response options, with additional space available for respondents to comment.

7.5 <u>Additional Error or Biases</u>

- Potential of someone, other than the proper or most involved individual in the LRP, receiving and answering the survey.
- Requiring an over-demanding recall of the individual's perception or participation in the LRP.
- Uncertainty of terminology or misunderstanding of survey question.
- Conditional branching not always properly followed by respondents, this involves Q6 and Q7.

8. Data Results & Discussion

Survey questions are listed with response percentage, survey with results located in the appendix.

	Yes	No	Not Sure
Q1. Would you have preferred 0% financing loan over receiving a rebate to change your lights?	5%	80%	15%
Q2. If no rebate had been available, would you have changed to the new lighting?	33%	40%	27%
Q3. Did you have/use T12s in your previous lighting?	33%	51%	16%
Q5. Do you think energy efficiency programs are beneficial?	96%	1%	3%
Q6. Were you aware of energy regulations making certain lights obsolete or no longer manufactured?	74%	26%	N/A
Q8. Do you think lighting energy efficiency standards and regulations are beneficial?	74%	9%	17%

	Did not factor into decision	Nice but not necessary	Some-what Important	Very important, factored into decision	Would not have completed project without it
Q4. How much of a factor did rebate make in deciding to proceed with the lighting project?	2%	11%	20%	42.5%	24.5%

	Not at all	Slight impact	Some impact	Large impact	Sole reason for changing lights
Q7. If you were aware of the regulations, how much did this impact your decision to change your lights?	43%	26%	3%	24%	4%

8.1 Awareness of Regulations (Q 3, Q 6, & Q 7)

These questions are asked to gauge participant's knowledge of their existing lighting system, knowledge of regulation affecting lighting availability, and impact of regulation on their decision process. Often lack of information, asymmetrical information, and behavioral failure are reasons why consumers don't invest in EE (Tonn & Peretz, 2007; Gillingham et al., 2009).

Leading up to 2013, there was significant outreach by utilities, lighting manufacturers, and lighting suppliers to educate consumers of upcoming changes to rebate incentives and availability of lighting product due to regulations. Rebates for T12 systems would decrease to a fraction available in previous years (2012 and prior). This is due to utilities adjusting their minimum efficiency baseline to meet EISA standards.

Over one-quarter of respondents are unaware of lighting regulations and one-third of respondents had T12s and did not take advantage of significantly higher rebate available in prior years. Overlap in these categories would infer issues of asymmetrical information in regulation and lighting technology. Even with the best of campaigns, not all users of obsolete equipment can be notified of changes. Additionally, many people are unaware of the type of lighting they have and therefore unsure if regulations apply to them. If a participant had T12s (33 percent) and been aware of lighting regulations (74 percent), but not participated earlier due to cash flow, this would imply behavioral failure. In this situation, behavioral failure takes place when an individual knowingly underinvests in energy efficiency by not taking advantage of previously offered significantly higher rebates (Tonn & Peretz, 2007; Gillingham et al., 2009). This subgroup could account for 28 percent of respondents finding regulation a large or sole reason for participation.

Overall awareness of lighting regulations is quite high (74 percent), which should be attributed to the educational efforts of utility EE programs, lighting suppliers, and the DOE. In determining impact of EISA and DOE regulations to participant rates, 69 percent of respondents considered regulations having little or no impact on their decision to install EE lighting. This could be due to three reasons. First, their existing lighting system may have been exempt or not part of EISA and DOE regulations. Second, their lighting may have been minimally impacted by EISA and DOE regulations. Third, some LRP participants' existing systems may have been subject to efficiency regulations, but they were unaware of the lighting regulations (26%)[1].

[1] Disclaimer: Conditional branching was flawed in moving from Q6 to Q7. Q6 received 221 'Yes' responses to awareness of regulations affect lighting. Q7 received 250 responses on impact regulations made on their decision to implement new lighting. Data for Q7 would be more accurate if responses had totaled 221 or less.

8.2 **Perceptions of Regulations & Incentives (Q 5 & Q 8)**

The LRP offers technical assistance and cash rebate incentives to all eligible participants. Asking if energy efficiency programs are beneficial could be considered vague. Though given the survey sole context is LRP and EE, it is safe to infer survey participants understood the connection of LRP to ‘energy efficiency programs’. Overwhelmingly (96 percent) respondents find EE programs beneficial. When surveyed if lighting energy efficiency standards and regulations are beneficial 74 percent agreed.

There is two-fold reason for asking these questions: gauging respondent’s perception of EE incentives and regulations, and to compare these results. Participant buy-in is needed for both incentives and regulations to be effective and sustaining. Regulations can be overturned or undone by government officials, particularly if constituents raise enough support. Incentives are only successful if they are utilized and achieve the desired outcome. Resistance or negative beliefs to either can inhibit the intended goal.

A significant amount of LRP participants find both EE incentives and regulations beneficial. It is not surprising that incentives through the energy efficiency program are looked upon more favorably than regulations. People prefer choices over forced action, in addition to financial compensation to make a choice (Stern, 1999; Gillingham et al., 2009). Given LRP participant high awareness (Q6. 74 percent) and equally high perceived benefit (Q8. 74 percent) of EE standards and regulations, it appears respondents see EE standards and regulations positively. Respondents like the ‘carrot’ more, but the ‘stick’ isn’t so bad.

8.3 **Incentives Needed if Regulations Exist? (Q 2 & Q4)**

These questions look at the most frequently cited issues with incentives: free-riding and behavioral failure.

Some organizations, public officials, and individuals argue that incentives offered by utilities or the government are unnecessary. Those opposed to incentives question energy savings and usefulness of incentive based EE programs. Concerns include: biases from utilities calculating cost-effectiveness of DSM, extent of free-riding, economic efficiencies, moral hazards[2], and behavioral failure (Graetz, 2012; Loughran & Kulick, 2004; Wirl, 2000). Behavioral failure stems from the belief a ‘smart consumer’ would switch to something more efficient regardless, because it would save them money and therefore energy (Jacoby-Hawkins, 2014). Free-ridership is when people would have purchased the energy efficient equipment without needing incentives, but still applies for and receive the incentive. In addition to free-riding, those opposed to EE incentive programs raise concerns on equity in tax codes and rate-payer contributions to conservation improvement funds, which fund many utility EE incentive programs (Fullerton, 2001; Graetz, 2012).

Some of these concerns are valid and useful. Particularly in determining the need and amount of incentives, and calculating actual energy savings from EE programs. There are counterpoints to the contentions of freeriding and behavioral failure. The spillover effects, where others implement energy efficient equipment without rebates is not acknowledged by those opposing incentives (Gillingham et al., 2006). The argument of free-ridership is dispelled when considering the avoided cost of building additional power sources. These avoided costs benefit all utility customers, whether or not they participate in an EE program. Studies of data used by those asserting energy savings from EE policies are inflated or outright fraudulent have been refuted (Auffhammer et al., 2008). Additionally, incentives and information from DSM programs correct asymmetrical information by providing credibility to the incentivized EE technology, leading to increased dispersion (Anderson & Newell, 2004; Tonn & Peretz, 2007).

When asked “if no rebate had been available, would you have changed to the new lighting”, 33 percent of respondents said yes (Q2). This would imply free-ridership, as

[2] Moral Hazards in this context refers to utility customers strategically using less efficient technology knowing the utility will (increase the) subsidize for more EE equipment. Or the potential of utility customer lying about existing equipment to obtain cash incentive from the utility.

respondents would make the change regardless of rebate. Noteworthy to this discussion, the respondents that had T12s (33 percent) which are affected by regulations, is the same percentage that would have switched without rebate (33 percent). New lighting systems implemented by T12 users must be more efficient than the EISA baseline to qualify for rebate incentives. Meaning these new systems are more efficient than the regulatory minimum. In this scenario, free-riding is not only prevented, but used to increase energy savings. This is done by successfully incentivizing LRP participants to go above-and-beyond the regulated energy savings.

The results from Q2 are more complicated than expected due to respondents choosing 'Not Sure' (27 percent). This could be attributed to satisfaction of energy savings or reduction of CO2 footprint from the new lighting system. Though, most likely uncertainty results from improved working condition. In my experience as a lighting consultant, the response of 'Not Sure' is due to light quality improvements. Typically customers enjoy or find the new lighting superior to the existing. Finding the investment in lighting worth it, possibly without rebate. Often I hear LRP participants say they could never go back to the old lighting. This is an interesting area to consider, as incentives correct behavioral failure and asymmetrical information in 'Not Sure' respondents.

A significant portion (40 percent) would not have changed to more EE lighting without rebate. From an economic standpoint, incentives work to correct behavioral failure in this subset. Important for policy makers and EE program facilitators to consider, potentially two-thirds of participants (No and Not Sure respondents) would not have installed EE lighting without rebate. The incentive stimulates significant interest in EE measures.

Further gauging incentive significance, this survey analyzes how much rebate factors into the decision making process. This question produces distinctive response. Rebate clearly factors into the decision, 87 percent finding the rebate somewhat important, very important, or would not have completed the project without it. Only 13 percent of LPR respondents find the rebate not necessary or not even factoring into the decision. These results show incentives are a significant factor in deciding to participate in an EE program, further dispelling the concerns of free-riding. Policies that address both market and behavioral failures are highly effective (Gillingham et al., 2009), the LRP incentives are targeting both failures successfully.

8.4 Preferred Type of Incentive (Q1)

Given survey length and number of perspective respondents, locating incentive 'tipping point', the point when a respondent would or would not proceed with the EE measure, is not feasible. Instead the survey looks for incentive preference. The choice given to respondents is the cash rebate incentive received or zero percent interest rate financing option. Majority of respondents prefer their cash rebate incentive (80 percent) compared to those preferring no interest financing (5 percent), with 15 percent of respondents unsure of their preference. Stern's 1999 study on participation rates and EE incentive preference between cash incentives or zero-interest loans found similar results (Stern, 1999). These results may sound obvious, but policy makers and EE program facilitators should take this into consideration. Even when financed for "free", majority of EE participants would prefer a rebate cash incentive.

Often policy makers and EE advocates tout lack of financing significantly prevents EE improvements. The ability to finance EE projects should be available, especially to avoid consumers underinvesting in EE technology (Gillingham et al., 2009). Though access to cash or financing constraints, have yet to be empirically established (Gillingham et al.,

Highlights from LRP survey responses:

- Cash rebate incentives are considered more valuable to EE program participants than financing options
- Rebate incentives are a significant motivator to EE program participants, dispelling concerns of free-riding
- Even if participation wasn't solely motivated by rebate incentive, 94 percent consider energy efficiency programs beneficial
- Generally EE program participants are aware of regulations
- Lighting regulations played a minor role in implementation of EE improvements
- While both are viewed favorably by LRP participants, EE programs are considered more beneficial (96 percent) than EE standards and regulations (74 percent)

2009). This survey confirms trading-off rebate incentives for financing, even 0 percent financing, would prove costly to EE participation rates. LRP respondents clearly find value in the cash rebate incentives offered.

8.5 Overcoming EISA Barriers

Are utility customers aware of regulations affecting them? Yes, they are.
Will utility customers become resistant to implementing EE improvements due to 'force' of regulations? No, regulations appear understood and considered beneficial.

The most surprising survey response: almost three-quarters of respondents are aware regulations impacted their lighting choices. In my field experience, most individuals are unaware of the lighting system at their work, place of worship, or even at home. Quite possibly some respondents are aware of changes, but unaware of how they will be affected. Though as expected, some LRP participants gave 'colorful' responses referencing government infringement on choice and allowing free-market correction, but majority of comments were positive. Publicizing changes to lighting stock and gradual phasing out of inefficient products by media and concerted efforts of DOE, electric utility EE programs, lighting manufacturers, and lighting suppliers, can be credited with such high consumer awareness. Due to these education efforts, the public was aware of upcoming changes and could prepare. Granted some prepared by stocking up on lamps that would no longer be sold. Though many looked to change out their inefficient lighting and participate in LRPs, such as this one.

How will utilities meet EE goals with decreased reported savings due to EISA's impact? By educating and encouraging customer participation in EE programs, such as the LRP.

"[G]reater DSM/EE program efforts…make the adoption of DSM/EE programs more likely and also increase, on average, the total amount of savings" (Carley, 2012). Incentive and educational efforts should not be overlooked when considering EE policy and regulations. In this situation, knowledge is power to make an educated decision in whether or not to participate in an EE program. Previous surveys also find the importance of educating and incentivizing those who implement EE equipment (RFF, 1979; Stern, 1999; Horowitz, 2001; Anderson & Newell, 2004; Geller, 2006; Heap & Kasemo, 2010). Even stating aggressive incentivizing efforts should be made to encourage energy conservation (Ford Foundation, 1979). Incentives are needed because even if regulations exist, energy conservation (on the individual level) can't be mandated (Ford Foundation, 1979).

What can be done to encourage utility customers to adopt the newest energy efficient lighting technologies available, such as LEDs and 25w and 28w 4' T8 lamps?
Evaluate cash rebate incentive offerings, particularly to encouraged high energy saving technology. Periodically survey EE rebate program participant interests and desires.

Rebate incentives are an important tool to maximize participation in EE programs. A 2001 study found T8s were 50 percent of the market share in areas that offered EE rebates, compared to 30 percent in areas that offered no rebates (Horowitz, 2001). Additionally, from 1986 to 2000, 74 percent of electronic ballasts purchased were due to EE programs, resulting in energy savings that reduced emissions by 12 million metric tons of CO_2 (Horowitz, 2001). Incentivizing EE technology to increase dispersion and implementation works. LRP respondents clearly find value in utility offered incentives. This is shown with 87 percent finding rebate somewhat important, very important, or would not have completed the project without it. Finding value in EE programs is echoed by 96 percent of LRP respondents stating these programs are beneficial.

Synthesizing the prior points and integrating them into policy is important. Too often policy makers, DSM program facilitators, and EE advocates focus on their own objectives, without taking into consideration what their constituents, customers, and target audience value. By doing so, they overlook a key stakeholder in this process: the program participants. Policies are most effective when designed from the consumer's perspective (Stern, 1999). By understanding what potential EE program participants' value, EE programs can be tailored to increase implementation, participation, and reduce overspending on programs that are underutilized.

Minnesota's EERS regulations and incentives create a mutually beneficial relationship between State government, utilities, and electric customers. Within these relationships EISA has become a factor. State government regulates and incentivizes utilities EE, but EISA now influences both aspects. Utilities incentivize customers to participate in EE programs, but those incentives are now based on EISA regulations. In the "post-EISA" era, the LRP study provides unique insight to the dynamics of regulations and incentives and how they influence EE program participation. Data from this survey reinforces the need for both incentives and regulations. Focusing on proper type of incentives and appropriate mix of incentives partnered with regulatory policy.

9. Conclusion

After reviewing three Federal lighting policies and the LRP, it is clear the most successful EE policies involve both the 'carrots' and 'sticks'. Regulations provide minimum efficiency requirements for technology, but offer little inspiration. Incentives may be key in creating EE innovation. Initially, it would be easy to view EISA as infringing on utility's ability to incentivize DSM participants and creating barriers in meeting state mandated EERS, but that would only tell half the story. EISA should be credited for innovating lighting policy. Through EISA and incentives, the L Prize revolutionized the lighting industry and LEDs. The LRP survey reviews the effects of EISA on DSM programs. One year after significant DOE and EISA regulations went into effect, the LRP survey shows most participants are supportive of EE regulations and rebate incentives are a key motivator in implementing EE lighting. Understanding participant perceptions and barriers to EE programs is one way to improve policy design.

Innovation and implementation is needed to advance energy savings. Regulation and incentives are the policy levers to provide them. Therefore, policies that create a partnership between regulations and incentives provide the most effective energy savings.

Regulation + Incentives = *Innovation*
Regulation + Incentives = *Implementation*
Innovation + Implementation = Energy Savings

To encourage technology improvements or when innovation appears stymied, policy makers should consider pairing regulation with incentives. In the same vein, if regulations can spur consumer adoption of new EE technology, then regulatory policy alone may be able to advance EE. But typically new EE technology is more expensive than the existing option. In order to counterbalance the incremental cost and increase the rate of dispersion, policies that offer incentives for EE technology is needed.

Too often regulations and incentives get a bad rap, one being too heavy-handed, and the other too free-handed. As shown through the LRP survey, EISA, and the L Prize, regulatory policy can remove uncertainty and foster EE innovation and implementation through the correct use of incentives. Policy makers should take these successful results into consideration when formulating future energy policy. The carrot and stick are better together, working hand-in-hand to achieve optimal energy saving outcomes.

Small Business Lighting Program
Post-Installation Questionnaire

ID #: Contact Name: Phone:

Company Name:

Address:

Date Work Completed:

1 – Would you have preferred 0% financing over a rebate to change your lights?
❑ Yes ❑ No ❑ Not sure

Respondents: 298 Yes: 15 No: 239 Not Sure: 44

2 – If no rebate had been available, would you have changed to new lighting?
❑ Yes ❑ No ❑ Not sure
If yes, why? ______________________________
____

Respondents: 300 Yes: 99 No: 121 Not Sure: 80

3 – Did you have/use T12s in your previous lighting?
❑ Yes ❑ No ❑ Not sure

Respondents: 301 Yes: 99 No: 154 Not Sure: 48

4 – How much of a factor did the rebate make in proceeding with the lighting project?

❑ Did not factor into decision
❑ Nice but not necessary
❑ Somewhat important
❑ Very important, factored into decision
❑ Would not have completed project without it

Respondents: 301
Did not factor into decision: 7
Nice but not necessary: 32
Somewhat important: 60
Very important, factored into decision: 128
Would not have completed project without it: 74

5 – Do you think energy efficiency programs are beneficial?

❑ Yes ❑ No ❑ Not sure

Respondents: 295 Yes: 284 No: 3 Not Sure: 8

6 – Were you aware of energy regulations making certain lights obsolete or no longer manufactured?

❑ Yes ❑ No

Comments:____

____

Respondents: 299 Yes: 221 No: 78

7 – If you were aware of regulations, how much did this impact your decision to change your lights?

❑ Not at all
❑ Slight impact
❑ Some impact
❑ Large impact
❑ Sole reason for changing lights

Respondents: 250
Not at all: 87
Slight impact: 53
Some impact: 54
Large impact: 48
Sole reason for changing lights: 8

8 – Do you think lighting energy efficiency standards and regulations are beneficial?

❑ Yes ❑ No ❑ Not sure

Other (please specify):____

____

Respondents: 300 Yes: 222 No: 27 Not Sure: 51

9 – Any additional thoughts or comments on the lighting program?

Comments:____

____

Bibliography & Resources

Alliance to Save Energy. “Congress Passes FY 2012 Appropriations, Limits Funding For Energy Efficiency”, (December 19, 2011). https://www.ase.org/resources/congress-passes-fy-2012-appropriations-limits-funding-energy-efficiency

American Council for an Energy-Efficient Economy. Energy Efficiency Resource Standards. http://www.aceee.org/topics/eers. Accessed: August 20, 2014.

American Council for an Energy-Efficient Economy. “The 2011 *State Energy Efficiency Scorecard”*. (November 2011).http://www.aceee.org/sites/default/files/publications/researchreports/e115.pdf p.v.

American Council for an Energy-Efficient Economy. “The 2012 *State Energy Efficiency Scorecard”*. (November 2012). http://www.aceee.org/sites/default/files/publications/researchreports/e12c.pdf p.viii.

American Council for an Energy-Efficient Economy. “The 2013 *State Energy Efficiency Scorecard”*. (November 2013). http://www.aceee.org/sites/default/files/publications/researchreports/e13k.pdf. p. 7.

Anderson, Soren T. & Newell, Richard G. (March, 2004). "Information programs for technology adoption: the case of energy-efficiency audits". Resource and Energy Economics, Elsevier, vol. 26, pages 27-50.

Bardach, Eugene. *A Practical Guide for Policy Analysis, 4th Edition.* United States of America: SAGE, 2012. Print.

Bell, Mathias et al. “Turbocharging Efficiency Programs”. Rocky Mountain Institute. 2011. http://www.rmi.org/turbochargingenergyefficiency

Burdette, Jessica. Communications at Ackerman Hall. October 7, 2014.

Carley, Sanya. Energy Demand-Side Management: New Perspectives for a New Era. *Journal of Policy Analysis and Management* Vol. 31, No. 1 (WINTER 2012), p. 27. Published by: Wiley on behalf of Association for Public Policy Analysis and Management. Stable URL: http://www.jstor.org/stable/41429256

CREE: Solid State Lighting Revolution. http://mzltg.com/blog/wp-content/uploads/2010/01/cree-presentation-part-1.ppt Accessed: October 1, 2014.

DiLouie, Craig. Lighting Controls Association. “Energy Policy Act of 2005 Encourages Energy-Efficiency Lighting with Tax Deduction”. (2005). http://www.lightingassociates.org/i/u/2127806/f/tech_sheets/Lighting_Controls_Associatioin.pdf

Eto, Joseph, et al. (1996). “The Total Cost and Measured Performance of Utility-Sponsored Energy Efficiency Programs,” *The Energy Journal* 17 (1): 31-51. http://eetd.lbl.gov/sites/all/files/publications/the-total-cost-and-measured-performance-of-utility-sponsored-energy-efficiency-programs.pdf

Eto, Joseph, et al. (2000). “Where Did the Money Go? The Cost and Performance of the Largest Commercial Sector DSM Programs,” The Energy Journal 21 (2): 23-49. http://www.jstor.org/stable/41322865.

Energy Information Agency. http://www.eia.gov/totalenergy/data/monthly/pdf/sec2_5.pdf. Accessed: August 8, 2014.

Energy Information Agency. http://www.eia.gov/tools/faqs/faq.cfm?id=99&t=3. Accessed: August 8, 2014.

Environmental Pollution Agency. “Carbon Pollution Standards”. http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-flexibility. Accessed: August 2, 2014.

Fischer, Carolyn. Torvanger, Asbjørn. Kumar Shrivastava, Manish. Sterner, Thomas. Stigson, Peter. "How Should Support for Climate-Friendly Technologies Be Designed?"*Ambio* Vol. 41, Supplement 1. Special Report: Future Climate Policy Development (2012), p. 43. Published by: Springer on behalf of Royal Swedish Academy of Sciences. Stable URL: http://www.jstor.org/stable/41417387

Friedrich, Katherine, et al. "Saving Energy Cost-Effectively: A National Review of the Cost of Energy Save Through Utility-Sector Energy Efficiency Programs". ACEEE, 2009. http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf

Fullerton, Don. "A Framework to Compare Environmental Policies". *Southern Economic Journal* Vol. 68, No. 2 (Oct., 2001), pp. 224-248. Published by: Southern Economic Association. Stable URL: http://www.jstor.org/stable/1061592

Geller, Howard. Harrington, Philip. Rosenfeld, Arthur. Tanishima, Satoshi. Unander, Fridtjof. "Policy for Increasing Energy Efficiency: Thirty Years of Experience in OECD Countries". *Energy Policy,* Vol. 34 (2006), pp. 556-573.

Gillingham, Kenneth. Newell, Richard G., Palmer, Karen. (2009). "Energy Efficiency Economics and Policy". *Annual Review of Resource Economics*, Annual Reviews, Vol. 1(1), pages 597-620.

Gillingham, Kenneth. Newell, Richard G., Palmer, Karen. (November, 2006). "Energy Efficiency Policies: A Retrospective Examination". *Annual Review of Resource Economics*, Annual Reviews, Vol. 31, pages 161-192.

Goulding, Charles. Goldman, Jacob. DiMarino, Nicole. (July 2008). "EPAct Tax Deductions for Lighting Projects Gain Wider Use". Facilities Net. http://www.facilitiesnet.com/lighting/article.asp?id=9216

Goulding, Charles. "EPAct Extension". Retrofit Magazine. http://retrofitmagazine.com/epact-extension/ Accessed: August 22, 2014.

Graetz, Michael J. "Energy Policy: Past or Prologue?", *Daedalus* Vol. 141, No. 2, The Alternative Energy Future, vol. 1 (Spring 2012), p. 38. Published by: The MIT Press on behalf of American Academy of Arts & Sciences. Stable URL: http://www.jstor.org/stable/23240277

H.R. 6—110th Congress. "Energy Independence and Security Act of 2007." 121 Stat. 1492. Public Law 110-140-Dec. 19, 2007. http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf

Heap, Brian and Kasemo, Bengt. *Ambio* Vol. 39, Supplement 1. Special Report: Energy 2050 (2010), pp. 22-25. Published by: Springer on behalf of Royal Swedish Academy of Sciences. Stable URL: http://www.jstor.org/stable/40801587 p.22.

Illuminating Engineering Society. "Philips CEO Discusses L Prize Win". http://www.ies.org/LDA/E-newsletter/2011/August/newswire/110808-PHILIPS.cfm Accessed: September 1, 2014.

International Association for Energy Economics. Stable URL: http://www.jstor.org/stable/41323011
Metcalf, Gilbert E. "Federal Tax Policy Towards Energy". *Tax Policy and the Economy* Vol. 21, (2007), pp. 145-184. Published by: The University of Chicago Press. Stable URL: http://www.jstor.org/stable/20061917

Jaffe, Adam B., Newell, Richard G. and Stavins, Richard G. "Utility Energy Efficiency Programs: *Too Cheap to Meter?*". The Electricity Consumers Resource Council. (2008). http://www.naesb.org/pdf4/dsmee_ee_programs.pdf. Accessed: August 7, 2014.

Jaffe, Adam B., Newell, Richard G. and Stavins, Richard G. "Technology Policy for Energy and the Environment". *Innovation Policy and the Economy* Vol. 4, (2004), p. 55. Published by: The University of Chicago Press. Stable URL: http://www.jstor.org/stable/25056161

Joskow, Paul L. "Energy Policies and Their Consequences After 25 Years". *The Energy Journal* Vol. 24, No. 4, Special Issue in Honor of Hans Landsberg and Sam Schurr (2003) , pp. 17-49.

Landsberg, Hans (Study Group Chairman) (1979). "Energy: The Next Twenty Years". A Report Sponsored by the Ford Foundation and Administered by Resources for the Future, Cambridge: Ballinger.

Metcalf, Gilbert E. "Federal Tax Policy Towards Energy". *Tax Policy and the Economy* Vol. 21, (2007), pp. 145-184. Published by: The University of Chicago Press. Stable URL: http://www.jstor.org/stable/20061917

Mim, Natalie, et al. "Assessing the Electric Productivity Gap and the U.S. Efficiency Opportunity". Rocky Mountain Institute. 2009. http://www.rmi.org/Knowledge-Center/Library/2009-08_AssessingElectricProductivityGap

Minnesota Sustainable Communities Network (MnSCN). Next Generation Energy Act of 2007. http://www.nextstep.state.mn.us/res_detail.cfm?id=4034. Accessed: August 22, 2014.

Nadel, Steve. "Appropriations Bill Amendment Attempts to Derail Efficient Lighting". The Energy Collective. (December 21, 2011). http://theenergycollective.com/aceee/72662/statement-aceee-executive-director-steven-nadel-light-bulb-provision-omnibus-federal-app

National Electrical Manufacturers Association. NEMA Summary and Analysis of the Energy Independence and Security Act of 2007. http://www.nema.org/Policy/Energy/Documents/NEMA-Summary-and-Analysis-of-the-Energy-Independence-and-Security-Act-of-2007.pdf Accessed: September 12, 2014.

Newell, Richard and Wilson, Nathan. Resources for the Future. "Technology Prizes for Climate Change Mitigation". June 2005. p. 4. http://www.rff.org/rff/Documents/RFF-DP-05-33.pdf

Osram Sylvania Lighting. 1994. "Relamping America: A guide to the Energy Policy Act of 1992". http://assets.sylvania.com/assets/documents/EPAct_1992.d9d145d9-114e-4f94-a961-19c792fc263d.pdf

Quinn, John Paul. (July 2011). LED History 101. Electrical Contractor Magazine. http://www.ecmag.com/section/lighting/led-history-101

Revisor of Statues, State of Minnesota. Chapter 136 – S.F.No. 145. Next Generation Energy Act of 2007. https://www.revisor.mn.gov/data/revisor/slaws/2007/0/136.pdf

Sheppard, Kate. "Spending Bill Protects Inefficient Light Bulbs & Money For Coal Abroad". Huffington Post. (January 13, 2014). http://www.huffingtonpost.com/2014/01/13/appropriations-bill-light-bulbs-coal-_n_4592334.html

Schurr, Sam H. (Project Director) (1979). "Energy in America's Future: The Choices Before Us". A Study by the Staff of the RFF National Energy Strategies Project, Baltimore: Johns Hopkins University Press.

Smith, Catherine. *Writing Public Policy: A Practical Guide to Communicating in the Policy Making Process, 3rd Edition.* New York: Oxford University Press, 2012. Print.

Stern, Paul. "Information, Incentives, and Proenvironmental Consumer Behavior". *Journal of Consumer Policy* Vol. 22 (4), (December, 1999). pp. 461-478.

Tonn, Bruce and Peretz, Jean. "State-Level Benefits of Energy Efficiency". *Energy Policy*. Vol. 35(7), (2007). pp. 3665-3674.

U.S. Department of Energy. DOE's Market Introduction Workshop: Market Evolution. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/chwastyk_mktevolution_portland2013.pdf Accessed: September 29, 2014.

U.S. Department of Energy. L Prize. http://www.lightingprize.org/ Accessed: August 25, 2014.

U.S. Department of Energy. L Prize PAR 38. http://www.lightingprize.org/PAR38.stm Accessed: September 30, 2014.

U.S. Department of Energy: LED Lighting Facts. "The Energy Independence and Security Act (EISA) of 2007". http://www.lightingfacts.com/Library/Content/EISA Accessed: July 29, 2014.

U.S. Department of Energy Solid-State Lighting Research & Development – Multi-Year Program Plan. (May 2014). http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2014_web.pdf

U.S. Government. PUBLIC LAW 109–58—AUG. 8, 2005. Energy Policy Act of 2005.

Wirl, Franz. "Lessons from Utility Conservation Programs". *The Energy Journal* Vol. 21, No. 1 (2000), pp. 87-108. Published by: International Association for Energy Economics. Stable URL: http://www.jstor.org/stable/41322856

Xcel Energy. 2012 Status Report & Associated Compliance Filings Minnesota Electric and Natural Gas Conservation Improvement Program Docket No. E, G002/CIP-09-198. (April 2013). http://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/MN-DSM-CIP-2012-Status-Report.pdf

Xcel Energy. 2013 Status Report & Associated Compliance Filings Minnesota Electric and Natural Gas Conservation Improvement Program Docket No. E,G002/CIP-12-447.06. (May 2014). http://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/MN-DSM/MN-DSM-CIP-2013-Status-Report.pdf p. 1, 2, 6, & 49.